Ganges Chasma Landing Site: Access to Sand Sheets, Wall Rock and Layered Mesa Material. James W. Rice, Jr., Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721-0092, jrice@lpl.arizona.edu

Introduction

The floor of Ganges Chasma offers an ideal landing site for the MSP 2001 lander (Figure 1). This site is exquisite both in terms of engineering constraints and science objectives.

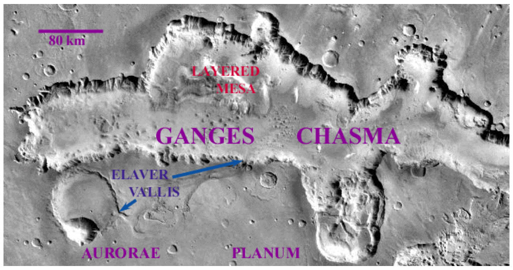

Figure 1. Ganges Chasma Region.

The floor of Ganges Chasma is mantled with an extensive low relief sand sheet (Figure 2).

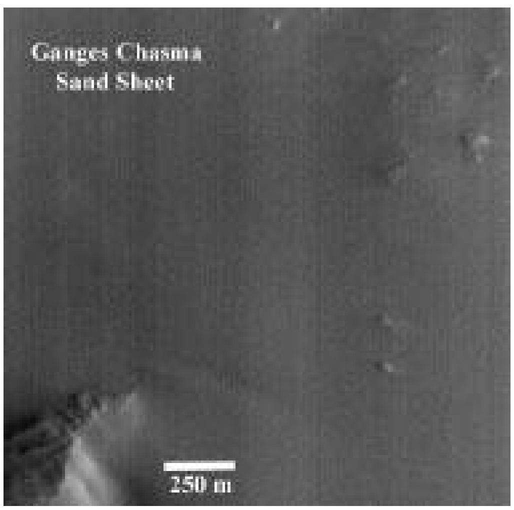

Figure 2. Ganges Chasma Floor (MOC image AB-1-028/02, 4.98 m/p).

Sand sheets develop in conditions which are unfavorable for dune formation. These may include a high water table, periodic flooding, surface cementation, and coarse grained sands [1]. The most extensive sand sheets on Earth are located in the eastern Sahara. These sheets have a relief of less than 1m over wide areas and total thickness ranges from a few cm to 10 m. The surfaces of sand sheets are composed of granule to pebbly lag deposits.

Engineering Concerns:

Sand sheets provide an extremely safe landing site and have very low relief. The safety concerns regarding slopes, rocks, and dust would be alleviated by the sand sheet.

Engine Exhaust

Viking Lander engine exhaust erosion studies were conducted on basaltic dune sand [2]. Test of exhaust induced erosion for basaltic dune sand found that about 20% was eroded to depths greater than 2 mm. Engine exhaust erosional morphology for basaltic dune sand consisted of a central area 1.5 m diam. which was cratered by exhaust gases. 18 small craters were seen which corresponded to the 18 nozzles of the engine, the deepest crater was 3.8 cm below the original surface. Ridges also formed between the individual craters which were 3.8 cm above the original surface: total relief was only 7.6 cm. Therefore, landing on sand should be no problem, based on the Viking Lander test data with basaltic sand.

Furthermore, this vast sand sheet would allow the Marie Curie Rover to travel 'maximum traverse distances' from the lander. The rover is good for 100 m actual travel on the Martian surface (drive motors, wheels, drive gear boxes are designed and qualified to support at least 100 m actual travel on Earth, followed by 100 m actual travel on Mars). This rover will have a 1m high whip antenna to permit line of sight broadcasting over the top of 0.5m high obstacles [3]. Rover navigability on the sand sheet would be very easy compared to the tedious rock avoidance maneuvers that Sojourner had to execute. This 'long distance' traverse exercise would be an important precursor test for the more capable Athena Rover which will perform longer traverses. Moreover, the Rover has already been 'field tested' on sand at the JPL Mars sandbox. Dust should not be a problem: Thermal inertia is 7.7 to 8.9 cgs units. This site satisfies all engineering constraints.

Science Objectives:

*What is the nature and source of the sand?

*What is the composition, grain size, shape, sorting, and stratigraphy of the sand?

*Is the sand monomineralic, lithic fragments, ice or salt cemented dust?

*What is the nature and composition of the Layered Mesa Material (lacustrine, aeolian, volcanic, other)?

*What is the nature and composition of the canyon wall material?

The philosophy for selecting this site is that it would allow analysis of Chasma floor material which should be composed of wall material and the layered mesa material, there is also abundant evidence of channels emptying into the canyon thereby providing a source for aqueous sediments. The morphology of the layered mesa material suggest that it is different from the surrounding canyon wall rock because no landslides are observed around the mesa walls and fine parallel fluting is observed on the mesa instead of the spur and gully morphology of the canyon walls. The layered mesa material also unconformably overlies the conical hills located on the canyon floor in some areas. The Robotic Arm (RA) will dig trenches into the substrate and be able to perform grain size analysis studies with the Robotic Arm Camera (RAC). The RAC is a lightweight monoscopic camera attached to the RA. RAC has a maximum resolution of 25 µm/pixel at close focus and 1.7 mrad/pixel at far focus (with a 50° X 25° field of view)[4]. A sample RAC high resolution scoop image from Baker, CA field test is shown in Figure 3.

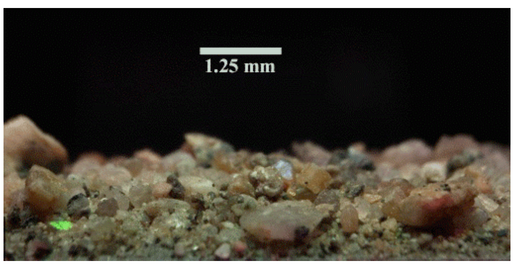

Figure 3. RAC hi-res view of grains in scoop.

Geologic Setting:

Ganges Chasma is located south of Shalbatana Vallis and north of Capri Chasma. Ganges Chasma is the type area for the Layered Material (interior layered deposits) located on the floors of the Valles Marineris. The walls are mapped as Noachian/Hesperian material with Hesperian layered material 100's m thick located on the floor of Ganges: this enigmatic material has been interpreted to be lacustrine, volcanic, aeolian deposits or remnant wall material. Amazonian alluvial deposits, landslides, sand sheets and dune fields are also found on the floor.

Numerous channels also empty into Ganges Chasma, the largest is Elaver Vallis. Elaver Vallis flows 160 km across the upper surface of Aurorae Planum before emptying onto the floor of Ganges Chasma, 4 - 5 km below, forming the largest waterfall in the Solar System. The source of Elaver Vallis is a 77 km diameter crater. The source crater is breached by an outlet channel 5 km wide, located on its southeastern flank. The crater rim height is calculated (shadow measurement) to be 450m above the crater floor. Using this as the upper limit for the water level in the crater yields a volume of water nearing 2,100 km^3 that would have drained into Ganges Chasma. This crater also contains what appears to be a sinkhole (40 km diam) located on its southern floor. The source regions of Shalbatana Vallis also appear to display a karst topography. This "karst topography" begs the question: what is the composition of the underlying layered plateau rock ?

Ganges Chasma Landing Site Characteristics:

*Landing Site Options**:***

Sand Sheet A: 7.9°S, 49.3°W
Sand Sheet B: 8.1°S, 48°W
Layered Mesa: 7.7°S, 48°W
Elevation: -1 to +1 km
Rock Abundance: 8 to 10 % (Floor and Mesa)
Thermal Inertia: Floor: 7.7 to 8.8
Mesa: 8.8 to 8.9
Fine Component: Floor: 7.0 to 8.3
Mesa: 7.2 to 7.8
Albedo: Floor: 0.1530 to 0.1740
Mesa: 0.1650 to 0.1700
Slopes: Floor: 0° to 3°
Layered Mesa Material: 0° to 5°
Layered Mesa Material: 100 X 45 km
Hazards: Minimal on the Sand Sheet
Exobiologic Potential: Region could contain aqueous sediments, thus good locale.
Wall Imaging: Landing at the various Sand Sheet locations would place the lander 30 - 50 km from the south wall (4 km high) of Ganges Chasma and only 5 to 10 km from the Layered Mesa (1-2 km high). If lander touchdown is 30 km from the south wall of Ganges, then RAC can image the wall. The wall would rise 7.4° above the horizon (76 RAC pixels; ~150 Pancam pixels). From this distance layering, >100m thick, in the wall would be observable. However, at a distance of 10 km from the wall of the Layered Mesa, which is 2 km high, the Mesa would rise 11.5 ° above the horizon (117 RAC pixels). Layers, >30m thick, would easily be visible. For comparison Twin Peaks rises about 3.5° above the horizon (or 36 RAC pixels).

Specific site characteristics such as rock abundance, thermal inertia, and albedo data were provided by [5,6,7].

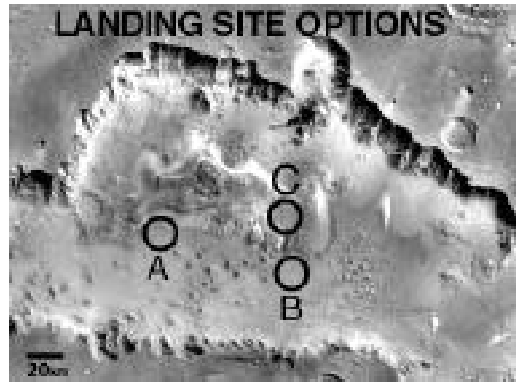

Figure 4. Landing Sites (20 km diam. circles).

References:
[1] Lancaster, N., 1995, Geomorphology of desert dunes, 290p. [2] Moore, H.J., et al., 1987, USGS Prof. Paper 1389. [3] Mars Surveyor 2001 Mission Plan Revision A, JPL, May, 1999. [4] Keller, U., et al., 1999, JGR, submitted. [5] Christensen, P.R., 1986, Icarus, 68, 217-238. [6] Palluconi, F.D. and H.H. Kieffer, 1981, Icarus, 45, 415-426. [7] Pleskot, L.K. and E.D. Miner,1981, Icarus, 45, 179-201.